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(12) UK Patent Application (19) GB (11) 2 388 966 (13) A

(43) Date of A Publication 26.11.2003

(21) Application No: 0212010.3

(22) Date of Filing: 24.05.2002

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(51) INT CL^7:
H02G 1/08

(52) UK CL (Edition V):
H2C CDB

(56) Documents Cited:
EP 0467463 A **US 6402123 A**
US 6364290 A **US 2002028058**

(58) Field of Search:
UK CL (Edition S) **H2C** CDA CDB
INT CL^7 **G02B 6/46, H02G 1/08**
Other: **Online: WPI, EODOC, JAPIO : Office collection of various trade catalogues.**

(54) Abstract Title: **Cable blowing machine**

(57) A machine 10 performs two functions to thread a cable 12 through a duct 13. Firstly the cable is fed into the duct 13 by contra-rotating rollers (23, fig 2) which are adjustable to allow cables 12 of different diameters to be driven. The cable 12 also passes through a sealed chamber (14, fig 3) which is connected to a source of pressurised air 15 to blow the cable 12 though the duct 13.

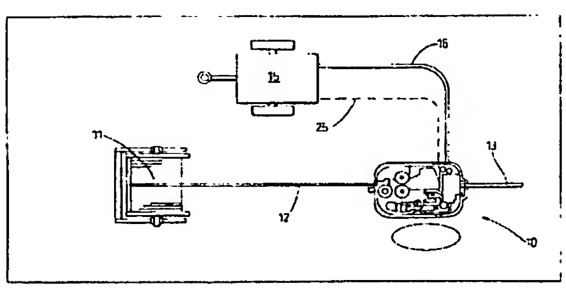

Fig. 1

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

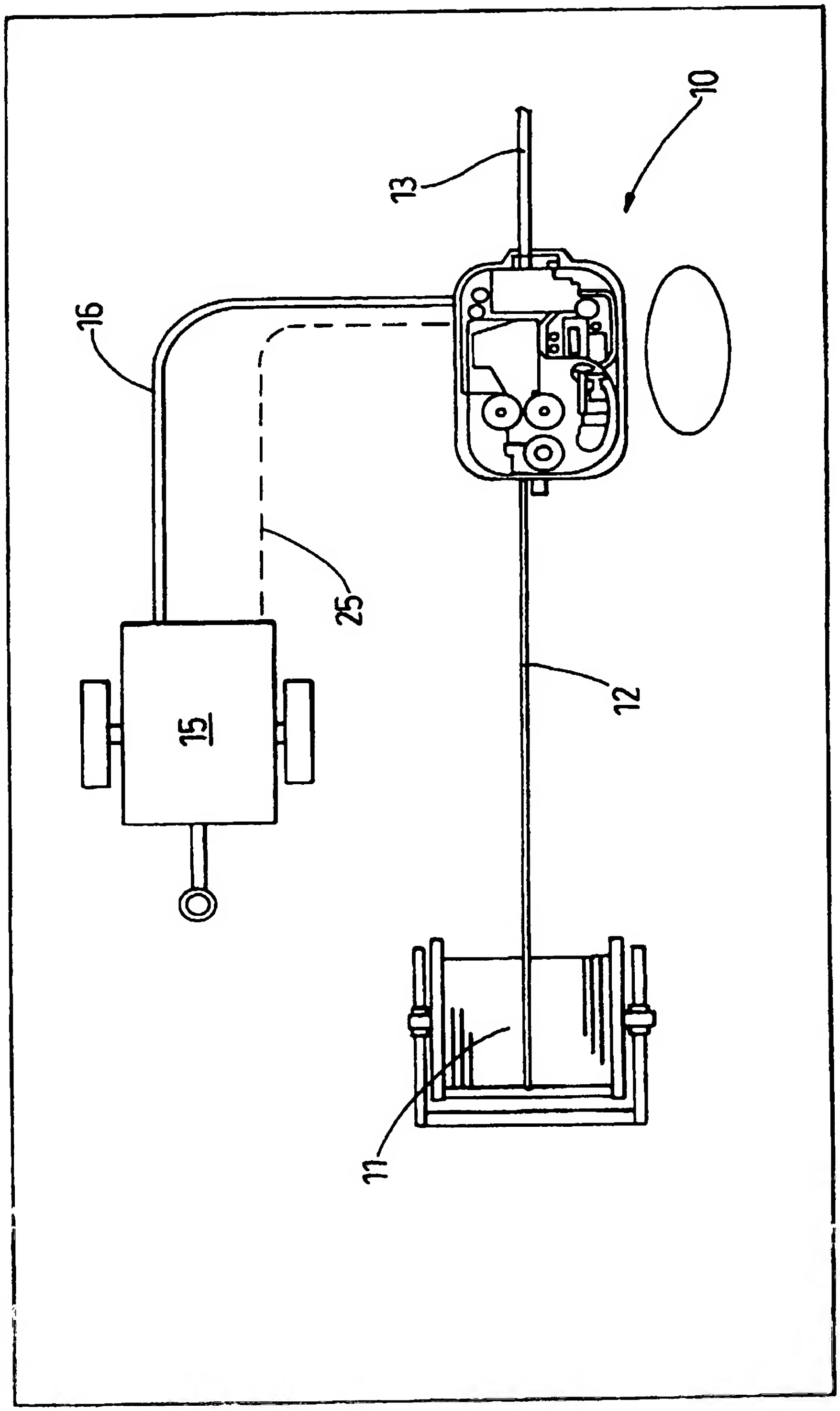

Fig. 1

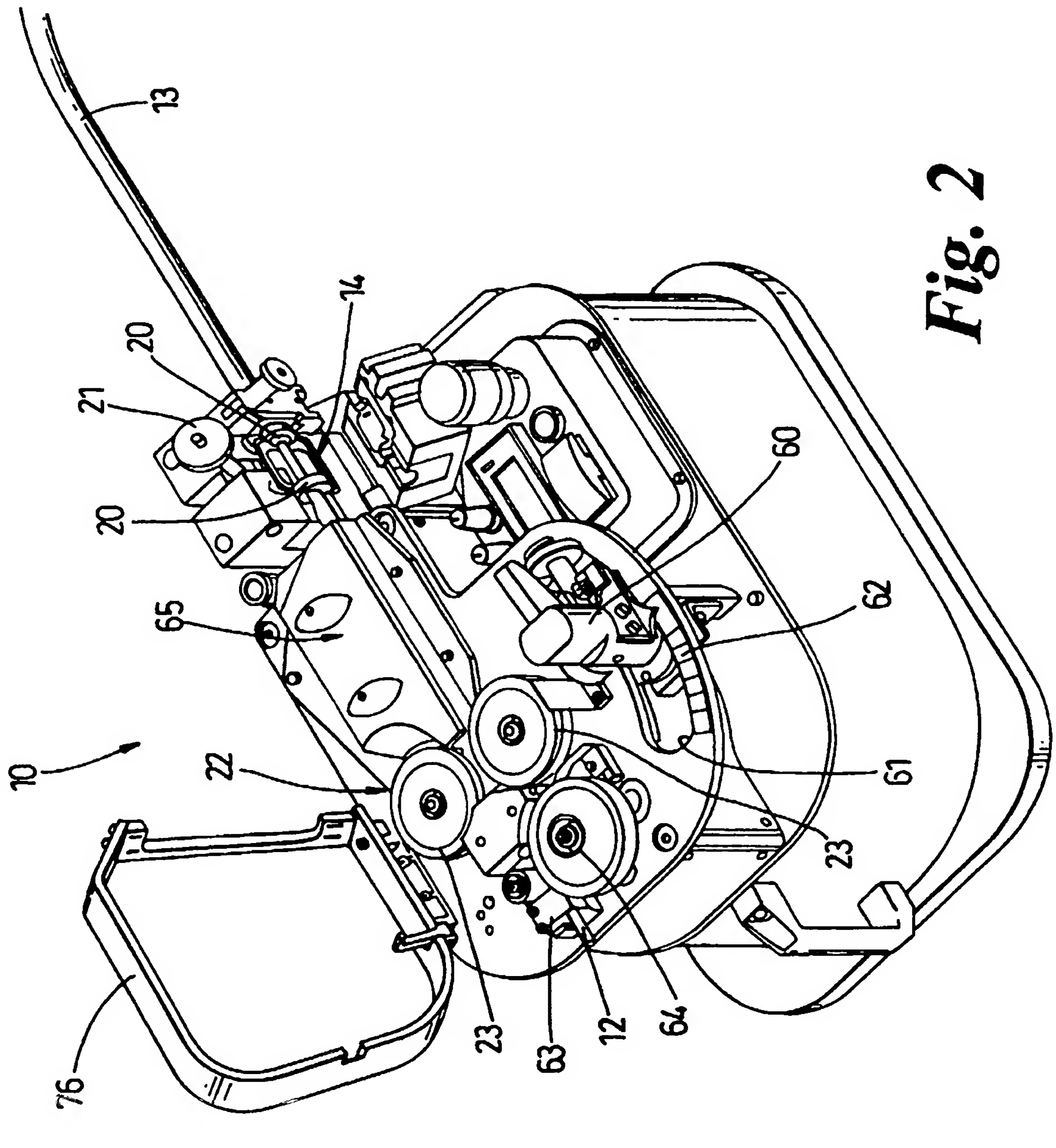

Fig. 2

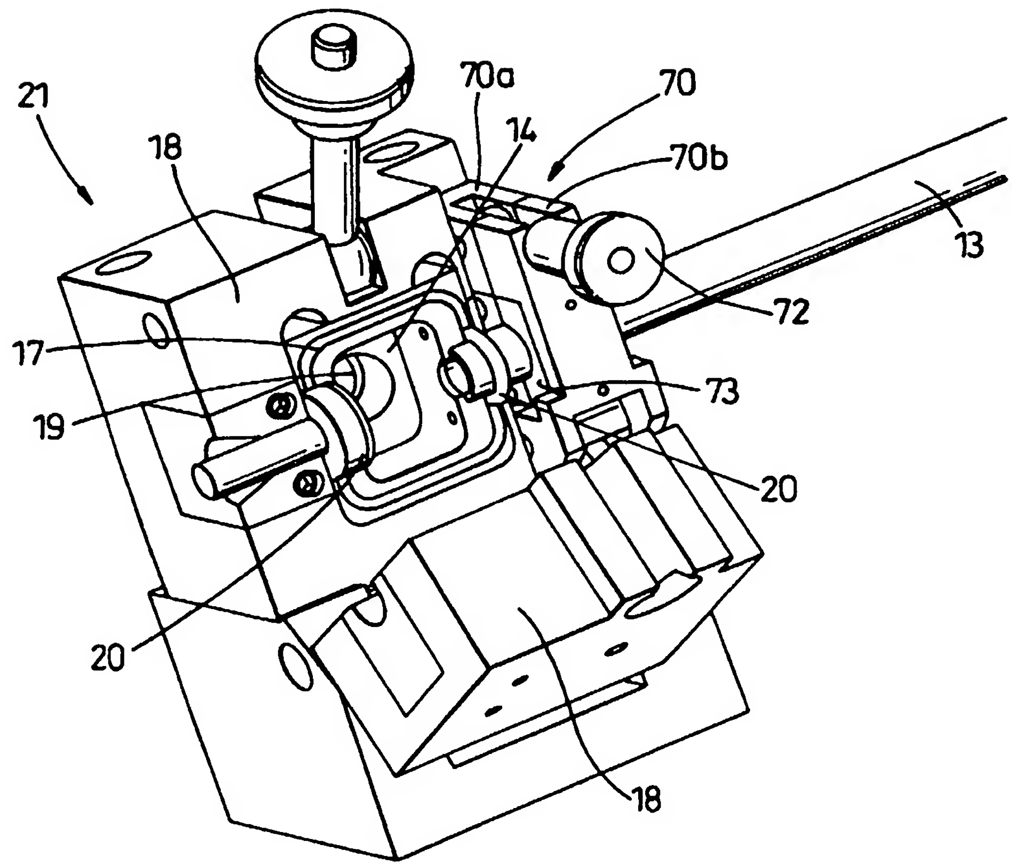

Fig. 3

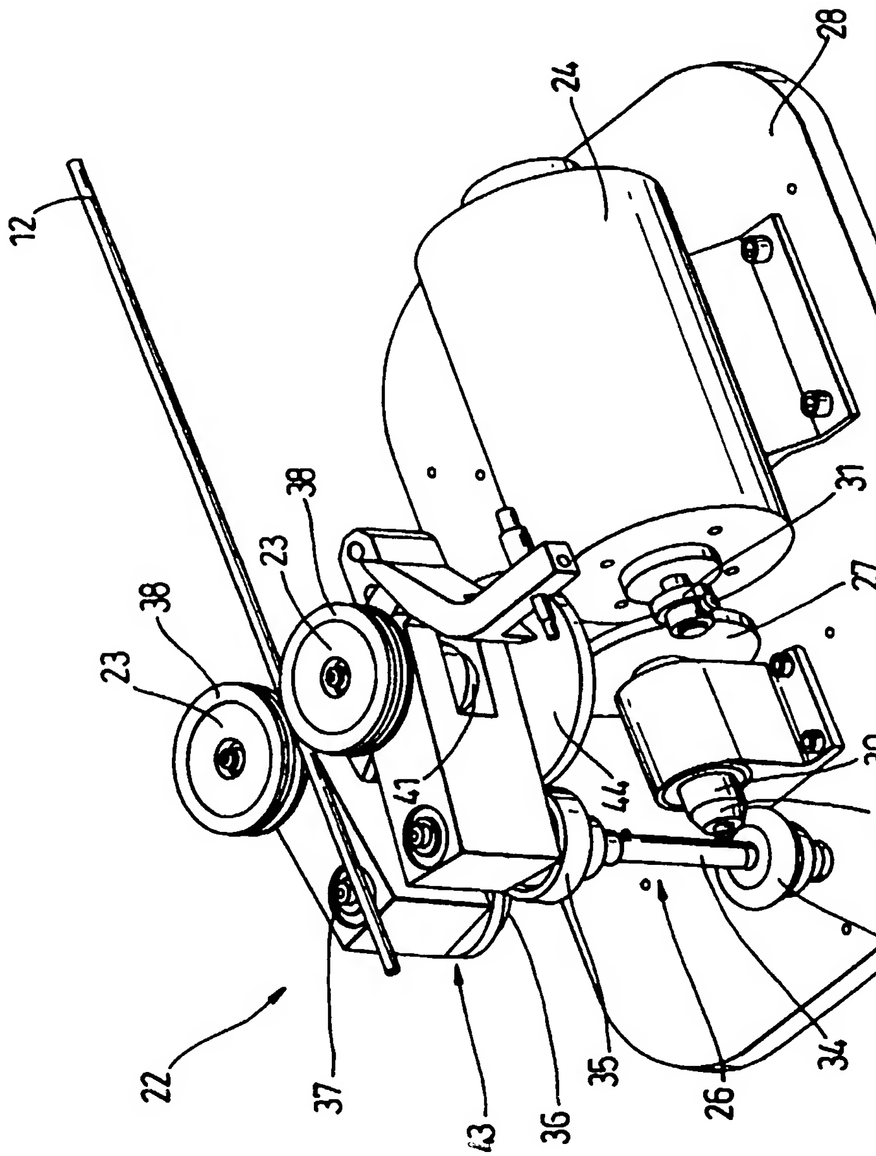

Fig. 4

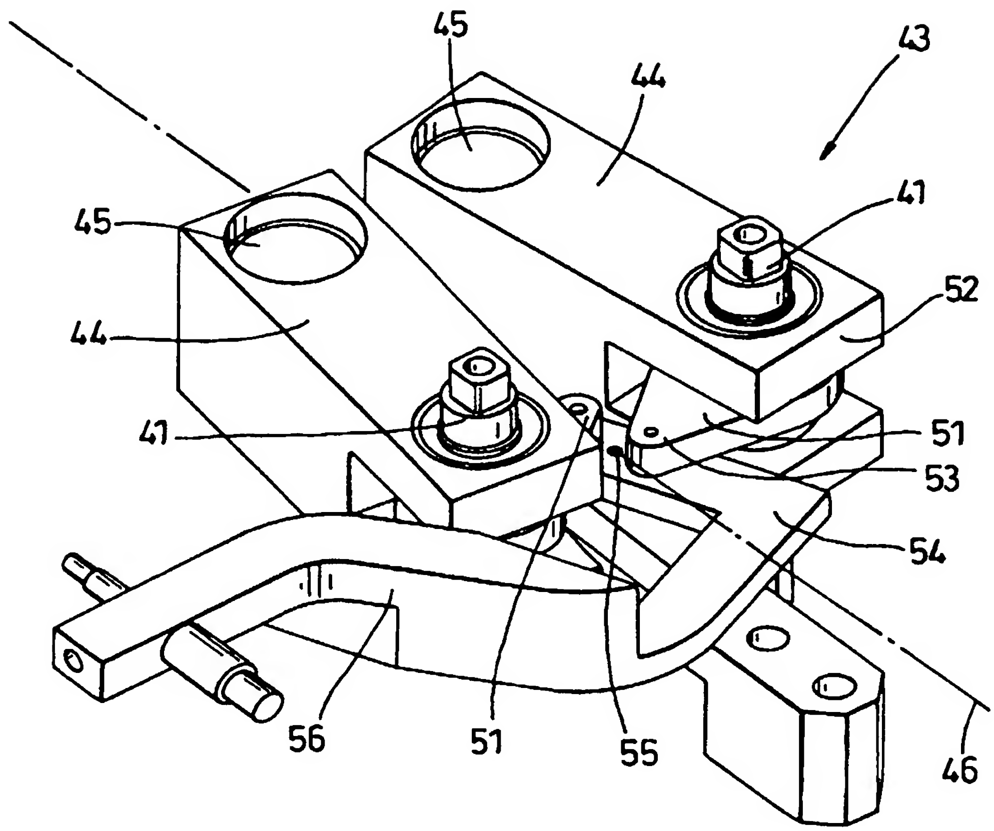

Fig. 5

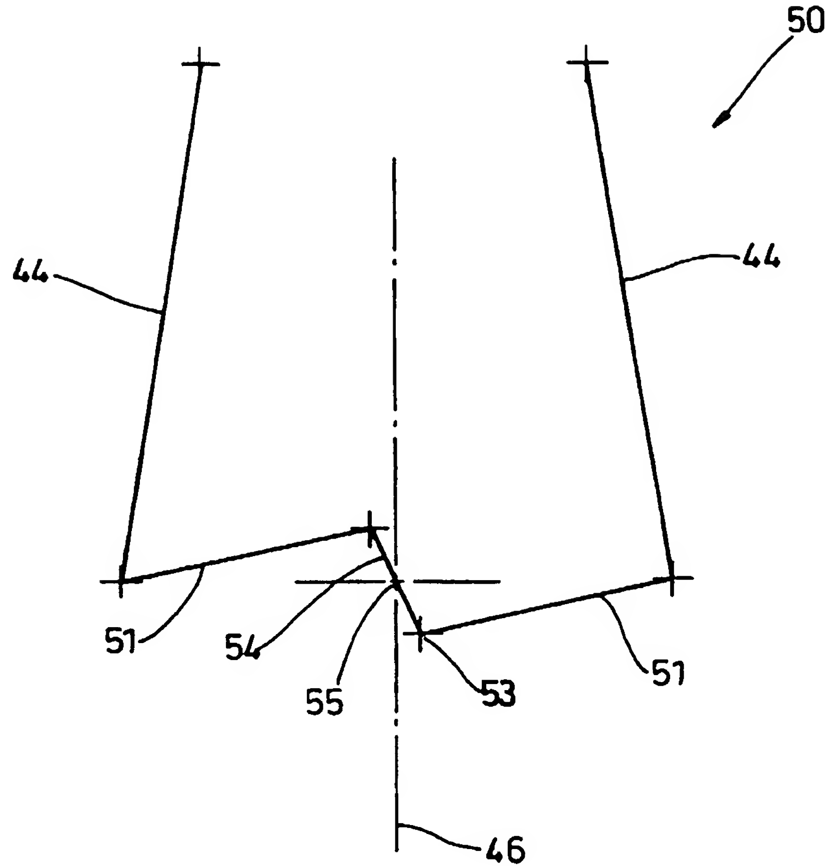

Fig. 6

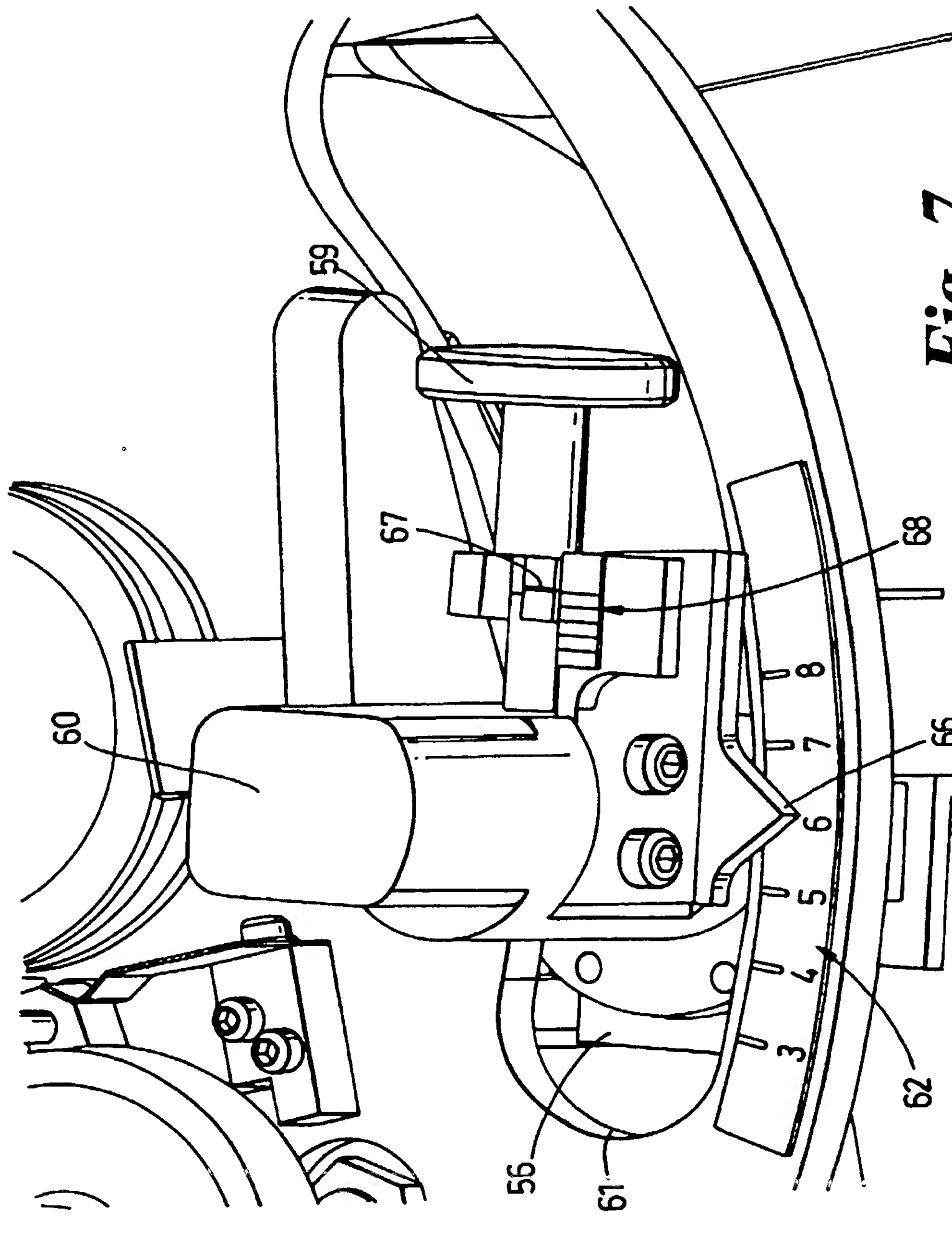

Fig. 7

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CABLE BLOWING MACHINE

The present invention relates to a machine for feeding cable into cable ducts. In assisting mechanical feed means to install cable the machine uses pressurised fluid to "blow" the cable through a duct using viscous drag principles.

Recent advances in cable installation have seen the adoption of "blowing techniques" using compressed air to propel cables into cable ducts. A mechanical drive, usually incorporating driving wheels, is still required but in conjunction with exertion by fluid drag cables can be propelled a far greater distance and with much more ease than solely by mechanical means. This technology is often used in the installation of so called "micro cables", in pre-installed tubes, and particularly copper or fibre optic cables.

Whilst the benefits in terms of efficiency and reduction of manpower are obvious, problems with known cable blowing machines are common. In particular it is difficult to ensure the cable is subjected to the optimum feed parameters. A single machine is likely to be used to install more than one type and form of cable. A less than optimum feed can lead to problems such as inadequate cable grip causing cable slip which cannot be overcome by the viscous forces. Too high a pressure on the cable by the mechanical feed means is likely to cause damage to the flexible outer sheath and the fibre contained therein. Fragile cables, such as fibre optic cables, are particularly susceptible to this problem.

The wide variety of cables to be installed means that particular feeding requirements for one cable will not necessarily apply to another cable having, for example, a different size or a different surface frictional coefficient. Additionally, in most cases cables are not precisely circular in cross-section but are oval or irregularly shaped making smooth cable

feeding difficult. Incorrect feeding of cables can also lead to undesirable cable buckling and, if persistent, cable destruction.

A cable blowing machine is therefore required that will reliably provide the advantages and efficiencies of known cable blowing machines but without the problems caused by incorrect cable feed.

According to the present invention there is provided a cable blowing machine that uses pressurised fluid to assist installation of a cable into a cable duct, the blowing machine comprising:

a mechanical feeding means driven by a driving means and including a gearing assembly linking the driving means to at least two contra-rotating driving rollers in between which is defined a cable path where a cable is adapted to extend and be moved in a forward direction by the mechanical feeding means, wherein the rollers apply equal pressure on the cable, the pressure being adjustable according to the characteristics of the cable so as to increase feeding control of the cable; and

a sealed chamber adapted to be coupled to a source of pressurised fluid and to a cable duct, the cable path extending through the sealed chamber wherein, in use, pressurised fluid is passed through the chamber and into the cable duct to assist installation of a cable.

Preferably, the circumferential edges of the rollers are provided with a compliant material to increase the frictional grip of the rollers on the cable. The compliant material is ideally a coating on the aforesaid circumferential edges and is typically a synthetic or natural polymer or rubber, such as polyurethane.

The pressure of the rollers on the cable is preferably adjusted by varying the spacing between the rollers. In a preferred embodiment each roller is mounted on a roller arm that is pivoted at a first end whereby pivotally

moving the arm from an axis of symmetry, with the arms substantially parallel on either side of the axis of symmetry, symmetrically moves the rollers apart. Accordingly, symmetrically pivoting the arms toward the central axis brings the rollers together.

Pivoting movement of the arms is preferably controlled by a lever assembly comprising a link pivotally secured at a second end of each roller arm and a pivot lever connecting the two links at connection points. The pivot lever is pivoted at a point between the link connections points and in line with the axis of symmetry.

The roller arms and lever assembly together create a five bar chain that ensures even and equal pressure is applied on the cable by each roller. Preferably, the pivot lever is manually movable to symmetrically adjust the spacing between the rollers and evenly adjust pressure applied to the cable depending on the characteristics of the cable.

The driving means is preferably an electrically powered DC motor having adjustable torque. The torque can be preset such that during use if the torque on the cable exceeds the preset torque a current sensor detects a maximum current and the torque is reduced thereby preventing damage to the cable.

The machine in a preferred embodiment has a cable buckle detector. When buckling of the cable is detected by the buckle detector the motor will either stop or adjust the torque of the motor to eliminate buckling.

Preferably, a cam located adjacent the cable path prevents the cable from moving backwards, that is in the opposite direction to the cable feeding direction.

There now follows a description of a preferred embodiments of the invention, by way of non-limiting example, with reference being to the accompanying drawings in which:

Figure 1 schematically illustrates a cable blowing machine according to the present invention together with service connections for installing a cable into a cable duct;

Figure 2 is a perspective view of the cable blowing machine;

Figure 3 is an enlarged view of the fluid chamber housing illustrated in Figure 2;

Figure 4 illustrates the internal working assembly of the driving means of the cable blowing machine;

Figure 5 is a perspective view of a linkage assembly of the machine;

Figure 6 is a bar chain diagram of the linkage illustrated in Figure 4; and

Figure 7 is an enlarged view of adjustment means of the machine illustrated in Figure 2.

A cable blowing machine 10 as illustrated in the Figures is used for installing cable, and particularly "micro cable" such as fibre optic cable, directly into pre-installed cable ducts or, alternatively, into tubes which are themselves installed into cable ducts. Hereafter fibre optic cable will be described as the preferred cable in context of the invention although it is understood that the cable could be metallic such as co-axial or twisted pair copper cable, or other. The fibre optic cable will be described in terms of installation into tubes.

In the context of this specification the term "micro-cable" is understood to mean a cable having a diameter of between 2.5 mm and 8.0 mm. These dimensions are typical of fibre optic cables. Additionally, the cable fed by the machine may not necessarily consist of a single cable but may be a

cluster of cables bound together and fed together into a cable duct as a single unit.

Using pressurised fluid from a source 15 separate to the machine 10 the machine relies on the principle of viscous drag between two surfaces separated by a fluid layer to assist in propelling the cable into the tube. Initially the cable is driven by a mechanical feeding means. Once the cable achieves sufficient momentum and has extended sufficiently into the tube pressurised fluid is delivered into the tube to carry the cable farther and more efficiently. The pressurised fluid is ideally compressed air, but other gases or liquids may be just as suitably used.

Figure 1 schematically illustrates the cable blowing machine 10 and its service connections including a cable supply having a cable drum 11 on which cable 12 is wound. Cable drum 11 is positioned in line directly behind the blowing machine 10. A tube 13 is sealingly clamped to the machine 10 and communicates with a sealable fluid chamber 14 (illustrated in Figure 2) in an air chamber housing 21. The tube 13 is pre-installed subterrain. The end of the tube to which the cable machine is connected extends above the ground. The other end of the tube may terminate below ground and be accessed through a manhole or may terminate above ground at its destination.

An air compressor 15 is located remotely of the blowing machine 10 and in practice on a vehicle (not shown). An air hose 16 supplies compressed air from the compressor to the blowing machine 10. The compressed air is supplied at a pressure of no more than 15 bar.

Figure 3 illustrates an enlarged view of the sealable chamber 14 of Figure 2. The sealed chamber 14 is illustrated in an opened and inoperative position with mutual housing halves 18 of the housing 21 hingedly

separated. Cable 12 is intended to extend through the sealed chamber 14 from one end thereof to the other but is omitted from Figure 3 for purpose of clarity. Sealing rings 20 at the cable entry point in the chamber and at the connection point with the tube 13 ensure the entrance and exit to the sealed chamber remain adequately sealed in use to prevent leakage of compressed air. A chamber seal 17 located in a groove on one housing half 18 fits into a corresponding groove in the other housing half 18 when the halves are brought together to form the chamber 14. The chamber seal 17 prevents air escaping from between the chamber halves 18.

Air hose 16 (not shown in Figure 3) is coupled to the air chamber housing 21 and communicates with the sealed chamber 14 through an internal passage 19 in the chamber housing 21. Compressed air from the air compressor is thereby supplied to the air chamber housing 21 and into the sealed chamber 14 to exit down into tube 13 together with the cable which is simultaneously fed by mechanical means and dragged by the compressed air.

As illustrated in Figure 2, and more closely in Figure 3 tube clamp 70 clamps the tube in a fixed position relative to the sealable chamber housing. This prevents the tube from shifting and creating leaks of compressed air past the sealing rings 20. Tube clamp 70 is hinged a lower end 71 to open into two facing halves 70 and 70b and allow installation of the tube. A swing bolt 72 is unscrewed and swung upward to unlock the two halves of the tube clamp 70. Since pre-installed tubes will not always be of the same diameter, a resilient tube clamp insert 73 is fitted on the inside face of each clamp half 70a and 70b and closely surrounds the circumference of the tube holding it firmly in position. The tube clamp inserts 73 are removable and interchangeable with other inserts designed for encasing tubes having larger or smaller diameters.

The machine's mechanical feeding means 22 is illustrated in its assembled state in Figure 2 and separated from the machine in Figure 4. The inter-working relationship of the components of the mechanical feeding means 22 is more clearly illustrated in Figure 4.

At an upper end of the mechanical feeding means are two contra-rotating drive rollers 23 in between which a cable passes and is driven in a forwardly direction. At a lower end of the mechanical feeding means 22 is the driving means, a permanent magnet electric DC motor 24 mounted on a mounting plate 28. The electric motor 24 is powered by an electrical source (not shown) remote of the machine 10. In other embodiments of the inventions the electrical source may be on board the machine 10. An electrical line 25 for supplying power from the electric source to the motor 24 is illustrated in Figure 1.

Transmitting drive between the electric motor 24 and both the drive rollers 23 is a gearing assembly 26. Specifically, the gearing assembly 26 includes a straight spur gear 27 mounted at one end of a layshaft 30. Spur gear 27 meshes with a drive pinion 31 mounted on the motor's output shaft. Mounted at the other end of the layshaft 30 is a straight mitre bevel pinion 32 that drives a straight spur mitre bevel gear 33 mounted on a long intermediate drive shaft 34. Intermediate drive shaft 34 extends upright relative to mounting plate 28 and a first upper pinion 35 is mounted at its upper end. The first upper pinion 35 drives a second upper pinion 36 mounted on a short intermediate shaft 37 extending parallel to the long intermediate drive shaft 34. Pinions 35 and 36 each drive a straight gear 40. Gears 40 are mounted on one end of separate drive roller shafts 41, with a drive roller 23 mounted at the other end of each shaft 41. Drive roller shafts 41 are necessarily parallel. Overall, the gearing assembly 26 ensures equal rotation and equal transfer of torque to both drive rollers.

Both drive rollers 23 are coated at their circumferential edge with a compliant covering 38 such that as the rollers come into contact with the cable the contacting roller edge deforms locally around the cable as it passes by. This maximises the surface contact area of the roller on the cable thereby maximising the friction between the rollers and cable, resulting in the maximum possible drive transmission to the cable.

The compliant coating is of a resilient material that is softer and more deformable than the outer sheath of the cable. This prevents cable damage experienced with known rollers that commonly comprise a knurled or serrated metal surface. While these known surfaces are designed to theoretically increase friction between the roller and the cable in practice it is found that the outer cable sheath is frequently damaged. The compliant coating used in the present embodiment is a synthetic or natural polymer or rubber. Polyurethane is one such example. The material is selected dependent on the extent of compliancy required for a particular cable. For instance, a delicate fibre optic cable would require more grip, and therefore more compliancy, than a more robust and grippable copper cable.

A roller adjusting mechanism 43, illustrated in Figure 5 separated from the feeding means 22, provides for variation in the distance between the rollers. Hence the width of the cable path can be adjusted according the width of cable to be fed.

Two roller supporting arms 44 of the adjusting mechanism 43 each receive through one end a drive roller shaft 41 on which a drive roller 23 is mounted. Apertures 45 at the other end of the supporting arms 44 receive the long and short intermediate drive shafts 34 and 37. Roller support arms 44 are pivotable about the fixed intermediate drive shafts 34 that are omitted from Figure 5 for clarity. Hence the drive roller ends of the arms 44 are free to rotate about their captive ends 47. When the arms are counter

rotated the effect is an increase or decrease in the spacing between the drive rollers 23 from an axis of symmetry 46. The axis of symmetry 46 coincides with the cable path in between the arms 44. The captive ends 47 of the arms 44 supported by the intermediate drive shafts are sufficiently spaced to allow the passage of a cable.

To ensure the roller arms 44 are counter rotated at precisely equal distances and symmetrically of the axis of symmetry 46, the roller supporting arms of the adjusting mechanism form part of a five bar chain 50 which is schematically illustrated in Figure 6.

The five bar chain 50 includes a link 51 pivotably attached to each arm 44. As shown in Figure 5, each link 51 is pivotably mounted at one end to a drive roller shaft 41 where it is captured between forked ends 52 of the associated roller supporting arm 44. The other end 53 of each link 51 is pivotably pinned to a lever 54 which is itself pivotably movable at a pivoting point 55 equally distanced between the pinned ends of the links 51 with the lever 54. Pivot point 55 of the lever 54 lies on the axis of symmetry 46.

The lever 54 extends beyond the pinned connection with one of the links 51 to form a handle 56. Roller adjusting mechanism 43 can be adjusted by moving handle 56. Illustrated in Figure 2 is an upright adjustment knob 60 mounted on handle 56 and reciprocally slidable in arcuate slot 61 which limits the minimum and maximum spacing between the drive rollers. Incremental markings 62 alongside the slot 61 indicate the spacing between the drive rollers. The spacing may be marked in dimensions of distance between the drive rollers, or alternatively, the incremental markings 62 may indicate the appropriate knob setting for a cable having a specific diameter. There may also be provision for fine force adjustment using a displaceable screw in addition to the direct manual adjustment of the knob.

Figure 7 illustrates adjustment knob 60 mounted on handle 56 together with a fine adjustment screw 59. To set the adjusting mechanism to an accurate predetermined value knob 60 is first moved in arcuate slot 61 until pointer 66 on the knob 60 aligns with desired incremental marking 62 adjacent the slot 61. For finer force adjustment screw 59 is rotated to displace the adjusting mechanism in finer increments, for example in increments one fifth in scale to the layer incremental markings 62 of the knob 60. An indicator 67 displaceable with adjustment screw 59 is aligned against fine markings 68 for accurate adjustment.

Fine adjustment screw 59 finely adjusts the load of the drive rollers 23 on the cable. The screw 59 includes a coil spring (not shown) which allows the pressure on the cable to vary slightly and accommodate imperfections or irregularities in the cable, for instance, experienced with non-circular cross-section cables. The give in pressure of the fine adjustment screw together with the compliance of the drive rollers allows for a controlled and well-gripped cable feed.

By accurate adjustment of the spacing between the drive rollers the pressure of the rollers on the cable can be adjusted. By trial and error or by use of predetermined settings the optimum pressure for the maximum transmission of force to a cable having a particular thickness can be selected.

The output torque of the motor may also be adjusted according to the stiffness of the cable in order to avoid the common problem of cable buckling. For instance, a cable susceptible to buckling would require a lower torque output than a stiffer, more resistant cable. Additionally, the output speed of the motor may also be adjusted to accommodate fragile cables susceptible to damage. Torque and speed are set by adjusting

variable torque and speed potentiometers provided on the motor.

The motor torque and speed are ideally predetermined before use to achieve optimum performance. Predetermined values could be obtained by testing and trialling samples of cable, for example to destruction or until an unacceptable degree of buckling becomes evident. In the case where the torque on the cable may exceed the preset motor torque, the cable blowing machine may be provided with an electronic means of slowing down or stopping the motor when the preset torque is exceeded.

To operate the cable blowing machine cable is firstly fed through the in-feed guide 63 illustrated in Figure 2 past the measuring wheel 64 and between driver rollers 23. The housing (not shown) of the cable blowing machine and other covers and clamps are removed or opened for access to manually thread the cable through the machine before operation. Guard 76 usually covers the infeed components and drive rollers but is hinged at one side to lift open as shown in Figure 2 and allow access to these components.

Sealed chamber 14 is also opened by separating hinged halves thereby permitting attachment of a tube and threading of a cable into the duct. Tube 13 is sealingly clamped at an output aperture of the sealed chamber 14 by tube clamp 70.

Adjustment knob 60 is moved to the far right of arcuate slot 61 in Figure 2 to separate the drive rollers 23 as much as possible. Cable is fed past cable guide parts which 65 guide the cable through the sealed aperture in the air chamber housing 21 and into the sealed chamber 14 where it enters tube 13.

The measuring wheel 64 lies adjacent and in contact with the feeding cable to rotate as the cable passes by. Its revolutions are electronically recorded

to provide a measurement of the length and speed of cable installed in the tube.

A pivoting cam (not shown) located in the cable guide parts 65 prevents the cable from moving backwards by creating a wedge against a backward moving cable.

If backward movement of the cable is required, for instance to unbuckle or dislodge a cable, the drive rollers can be made to rotate in the reverse direction to run the cable backward.

Drive roller pressure on the cable is applied by moving knob 60 towards the left of Figure 2 until the optimum pressure on the cable is reached. Adjustment of the guide rollers 23 moves them evenly towards and onto the cable to apply even pressure and equal torque to both sides of the cable to create maximum friction but without causing damage to the cable.

In the first instance the cable blowing machine is operated using the mechanical feeding means alone without supply of compressed air. Cable 13 is fed into the preinstalled tube mechanically for a reasonable distance, for instance 50-100 metres, before the air feed is turned on to assist feeding the cable into the tube. Distances covered using the cable blowing machine reach in excess of 2 kilometers with a cable fed at up 60m/min.

An electronic control system (not shown) provides readouts of speed and distance.

The cable blowing machine may be located above or below ground. When the distance to which a cable is to be installed is beyond the capabilities of a single blowing machine a "series blowing" type of installation is adopted. Typically this incorporates situating at least one other machine down a

manhole some distance from the first machine at the start of the cable installation. Driven by the first machine, cable entering the manhole from one side is picked up in the second machine and threaded in the normal manner into a tube sealingly attached to the second machine. The tube exits the manhole at an opposite side. In this way any number of machines can be operated in series to install cable to any desired distance.

The present cable blowing machine provides sophisticated control in feeding cable into preinstalled tubes by achieving an increased frictional drive and reducing incidences of mishap and cable damage.

CLAIMS

1. A cable blowing machine that uses pressurised fluid to assist installation of a cable into a cable duct, the blowing machine comprising:

a mechanical feeding means driven by a driving means and including a gearing assembly linking the driving means to at least two contra-rotating driving rollers in between which is defined a cable path where a cable is adapted to extend and be moved in a forwardly direction by the mechanical feeding means, wherein the rollers apply equal pressure on the cable, the pressure being adjustable according to the characteristics of the cable so as to increase feeding control of the cable; and

a sealed chamber adapted to be coupled to a source of pressurised fluid and to a cable duct, the cable path extending through the sealed chamber wherein, in use, pressurised fluid is passed through the chamber and into the cable duct to assist installation of a cable.

2. A cable blowing machine according to Claim 1, wherein the circumferential edges of the rollers are provided with a compliant material to increase the frictional grip of the rollers on the cable.

3. A cable blowing machine according to Claim 2, wherein the compliant material is polyurethane.

4. A cable blowing machine according to any one of the preceding claims wherein the pressure of the rollers on the cable is adjusted by varying the spacing between the rollers using an adjusting mechanism.

5. A cable blowing machine according to Claim 4, wherein the adjusting mechanism is a five bar chain that in use concurrently and symmetrically moves the rollers away from or towards an axis of symmetry that is co-linear with the cable path.

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6. A cable blowing machine according to Claim 5, wherein the five bar chain comprises two roller arms each pivotably supporting at a first end a roller and being pivoted at a second end; two links each pivotably secured at one location to the first end of one of the roller arms, the links being pivotably secured at a second location to a pivot lever having a pivot point equidistant from the second locations, the lever pivot point being located on the axis of symmetry whereby rotation of the lever results in equal counter movement of the rollers from the axis of symmetry.

7. A cable blowing machine according to Claim 6 wherein the lever is moved in reference to incremental markings.

8. A cable blowing machine according to Claim 7, wherein the incremental markings correspond to distance values between the rollers or cable properties.

9. A cable blowing machine according to Claims 6, 7 or 8 wherein the lever is provided with a fine force adjustment means for accurate rotation of the lever.

10. A cable blowing machine according to Claim 9 wherein the fine force adjustment means is a displaceable screw having a spring which allows for a small give in the pressure applied by the rollers on the cable.

11. A cable blowing machine according to any one of the preceding claims wherein the driving means is an electrically powered DC motor having an adjustable torque output.

12. A cable blowing machine according to Claim 11 having an upper torque limit wherein the motor is automatically stopped to prevent damage

to the cable if the torque on the cable exceeds the preset upper torque limit.

13. A cable blowing machine according to any one of the preceding claims wherein the machine is provided with a cable buckle detector wherein the motor is either automatically stopped or the output torque adjusted when cable buckling is detected.

14. A cable blowing machine according to any one of the preceding claims wherein a cam located adjacent to the cable path prevents backward movement of the cable.

15. A cable blowing machine according to any one of the preceding claims wherein the cable duct is clamped to the sealed chamber with a housing clamp having a removable insert for closely surrounding the cable duct and interchangeable with other inserts according to the size of the duct to be clamped.

16. A cable blowing machine according to any one of the preceding claims wherein the pressurised fluid is compressed air supplied at a pressure of no more than 15 bar.

17. A cable blowing machine according to any one of the preceding claims wherein cable is fed at a rate of 60 metres per minute.

18. A cable blowing machine according to any one of the preceding claims wherein the machine is capable of feeding a cluster of cables.

19. A cable blowing machine substantially as described herein with reference to and as illustrated by the accompanying drawings.

Application No:	GB 0212010.3	**Examiner:**	Joe Mitchell
Claims searched:	1-19	**Date of search:**	22 October 2002

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): H2C CDA, CDB.

Int Cl (Ed.7): G02B 6/46 ; H02G 1/08.

Other: Online: WPI, EPODOC, JAPIO : Office collection of various trade catalogues.

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	EP 0467463	NEDERLAND PTT (see rollers 21, contact pressure device 22 and parts 20,24 forming sealed chamber)	X:1,4,11,13,16-18 at least
X	US 2002028058	ELEFONAKTIEBOLAGET ERICSSON L M (see fig 2 and associated text)	X:1,4,11,13,16-18 at least
X	US 6402123	MARAIS SA (see chamber formed by seals 9 and 15	X:1,4,11,16-18 at least
X	US 6364290	BRITISH TELECOMMUNICATIONS (see buckle detectors 12,13, seal 6, blowing head of fig 10,	X:1,2,3,41 1,13,16-18 at least

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
		E	Patent document published on or after, but with priority date earlier than, the filing date of this application.
&	Member of the same patent family		